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AUTHORITY

**USNSWC ltr, 10 Jul 1975; USNSWC ltr, 10
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U. S. NAVAL PROVING GROUND
DAHLBRENN, VIRGINIA

REPORT NO. 1208

20MM AIRCRAFT GUNS, AN-M3 AND AN-M24
EXPERIMENTAL AND DEVELOPMENTAL TESTS

12th Partial Report

20MM AMMUNITION ASSIST FEEDER
DEVELOPED BY HARVEY MACHINE CO.

FINAL Report

Task

Assignment PPG-ROBB-108-20-52

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NPG REPORT NO. 1208

20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

PART A

SYNOPSIS

1. This report covers the evaluation of a Harvey Assist Feeder in conjunction with 20mm aircraft gun Mk 16 as suggested by reference (b). The salient features that were to be designed into the mechanism are outlined as follows:

a. Supplies ammunition to gun feeder at essentially zero belt load regardless of belt pull between ammunition box and booster. This increases the reliability and possibly the average rate of fire.

b. Reduces "belt whip" by providing 1 1/2 rounds which can be withdrawn from the reservoir without any movement of the belt at the beginning of a burst. This reservoir action also cushions the stopping of the belt.

c. Prevents starving of gun during single shot or short burst operation (a condition which occurs in ammunition systems using ordinary booster).

d. Prevents overfeeding of gun through quick release action of single plate type magnetic clutch and "cushion" effect of reservoir.

e. Greatly reduces maximum current drain during starting under load, through unique idling system.

2. On basis of the results it is concluded that:

a. The Harvey Assist Feeder did not perform the task that it is designed to do, at least, not in conjunction with the 20mm aircraft gun Mk 16. Insufficient tests were conducted to definitely establish its performance in conjunction with the 20mm aircraft gun AN-M3.

b. No definite conclusions can be drawn concerning the location of defects in the design of booster since a completely satisfactory operation was never obtained. The tests were terminated after the anti-roll back ratchet wheel had failed.

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20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

TABLE OF CONTENTS

	<u>Page</u>
SYNOPSIS.	1
TABLE OF CONTENTS	2
AUTHORITY	3
REFERENCES.	3
OBJECT OF TEST.	3
PERIOD OF TEST.	3
DESCRIPTION OF ITEM UNDER TEST.	4
DESCRIPTION OF TEST EQUIPMENT	5
PROCEDURE	5
RESULTS AND DISCUSSION.	6
CONCLUSIONS	7
APPENDIX A - TABULATED FIRING DATA.	1-7 (Incl)
APPENDIX B - NPG PHOTOGRAPHS.	FIGURES 1-7 (Incl)
APPENDIX C - DISTRIBUTION	1-2 (Incl)

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20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

PART B

INTRODUCTION

1. AUTHORITY:

Reference (a) established Task Assignment NPG-Re8a-20-52 for experimental investigations and developmental tests of the 20mm aircraft guns AN-M3 and M24. This was amended by reference (b) to include the evaluation of the 20mm Harvey Assist feed mechanism.

2. REFERENCES:

- a. BUORD Rost ltr NP9 Re8a-JOW:nts of 20 Sept 1951
- b. BUORD Rost ltr NP9 Re8a-CFW:nts of 8 Feb 1952

3. OBJECT OF TEST:

The object of this evaluation was to determine the suitability of the Harvey Assist Feeder for use with 20mm aircraft guns AN-M3 and Mk 16 and their associated feed mechanisms.

4. PERIOD OF TEST:

a. Date of Project Letter	8 February 1952
b. Date Necessary Material Received	29 January 1952
c. Date Test Commenced	29 January 1952
d. Date Test Completed	11 March 1952

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20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

PART C

DETAILS OF TEST

5. DESCRIPTION OF ITEM UNDER TEST:

The Harvey Assist Feeder or Booster, shown in Figures 2 and 3, is designed to assist the feeding of the ammunition to the gun on the demand of the gun feed mechanism. This feeding action is accomplished by a 24 volt D.C. motor geared to a sprocket wheel through planetary reduction gears. The booster incorporates a single plate-type magnetic clutch and an ammunition reservoir having one and one half rounds capacity. A quick release action in the magnetic clutch is designed to prevent overfeeding of the gun feed mechanism. The electric motor in the booster idles at half speed when the gun arming switch is closed and the ammunition reservoir is filled with ammunition. This reduces the electric current required at the beginning of a burst and permits quicker acceleration of the sprocket wheel. When the gun feed mechanism pulls on the ammunition belt the magnetic clutch switch is actuated and the clutch is engaged. The sprocket then assists in feeding ammunition to the gun as long as the clutch is engaged. The sprocket wheel free wheels at 135 rpm and has nine sprockets. When the firing switch is released, the booster continues to feed until the ammunition belt depresses the clutch switch which in turn disengages the sprocket wheel from the motor. The motor resumes half speed operation until either the gun is fired again or the arming switch is turned off. To remove the ammunition belt from the booster in a direction opposite to feed, it is necessary to release the anti-roll back device in the motor. This is done by rotating the depressed slotted pin located in one end of the motor.

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6. DESCRIPTION OF TEST EQUIPMENT:

a. The following test equipment was used for the evaluation of the booster:

- (1) Batteries and a generator as a source for direct current electricity.
- (2) 20mm aircraft guns Mk 16 and AN-M3.
- (3) 20mm feed mechanisms Mk 8 Mod 0 and AN-M2.
- (4) Rigid box type gun mounts.
- (5) Two pieces of ammunition chuting each 3 feet long and a wooden ammunition box.
- (6) High speed movie camera, 35mm.
- (7) 20mm ammunition links M8E1 made by L. A. Young and Company.
- (8) Heiland Recording Oscillograph.
- (9) 20mm Ammunition, M90 series - 3745 rounds.

b. A photograph of the test setup is shown in Figure (1).

7. PROCEDURE:

A standard 20mm aircraft gun Mk 16 was used in the major portion of the evaluation. Various length bursts, both continuous and interrupted, up to 270 rounds were fired at ambient temperatures. The booster, energized by 27 volts D.C. from either batteries or generated power, was located approximately midway between the ammunition box and the gun feed mechanism. About three feet of ammunition chuting was attached to each end of the booster. The chuting was fixed rigidly on a wooden platform. For portions of the tests the voltage to the booster was changed to as high as 31 volts since it was suspected that the motor speed during feeding was not high enough to keep the gun feed mechanism supplied with ammunition. Also, the action of belt motion in the booster was studied by high speed motion pictures. The action of the clutch switch as well as the current and voltage supplied to booster motor were recorded by a Heiland Recording Oscillograph.

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8. RESULTS AND DISCUSSION:

Complete detailed results are included as Appendix (A). The results show that the booster does not supply ammunition at the rate required by a 20mm aircraft gun Mk 16 as is evidenced by failures to feed, link deformations on the outboard side of the gun feed mechanism belt retaining pawls, and belt separations between the gun feed mechanism and the booster. Only 19 of 64 attempts, exclusive of belt pull tests and stoppages from other causes, were successfully fired out. The tests were terminated because of the failure of the anti-roll back ratchet wheel in the booster before it was established whether this inability to maintain adequate ammunition supply was caused by the faster firing rate of 20mm aircraft gun Mk 16 (about 790 rpm as compared to 740 rpm using an AN-M3 gun) or by the more severe nature on belt motion of intermittent reciprocating feeding action of the Mk 8 feed mechanism as compared to more uniform flow of ammunition in the rotary action of the AN-M2 feed mechanism. Each of the three firing attempts made with a 20mm aircraft gun AN-M3 was a successful fireout. Even though the failures to feed cannot all be blamed on the booster, about one third of the failures to feed were accompanied by stretched links. This would indicate that a sizeable ratio of the failures to feed were directly chargeable to the booster. The motion pictures showed that there was considerable tension applied intermittently to the ammunition belt as it passes through the booster. A sequence of events taken from the motion pictures is included as Figure 6. The oscillograms showed that the clutch switch is open about 3/7 of the gun firing cycle, but that the clutch rarely disengages. It is seen from Figure 5 that the clutch pull-in is very rapid, about the order of 1 millisecond, but that the drop out is in excess of 50 milliseconds. The disturbances noted by both the voltage and current element in the motor circuit is apparently caused by surge of current drawn by the magnetic clutch slipping because of lubricants or other foreign materials on the faces of the plates. This was obviated by thoroughly cleaning them twice during the tests. While somewhat improved operation was obtained after the second cleaning, the belt separation and failures to feed were not entirely eliminated. The results appear anomalous, however, in that one form of gun feed malfunction which had been prevalent in previous firings of Mk 8 feed mechanisms using the same links was not noted in these tests. The double loops of the belt link deformed toward each other sufficiently permitting the link to ride off the stripper. The link would tend to follow the round into the feed throat causing a gun stoppage. Those links had a Rockwell C-36 hardness which is within the limits specified by

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20mm Ammunition Assist Feeder
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BUORD Dwg. 7238242. It was later found that links having Rockwell C-46 would function satisfactorily in the 20mm feed mechanism Mk 8. The motor load current and voltage was an average about 11 amperes and 23 volts D.C. The transient current at the beginning of a burst is approximately as high as 65 amperes under normal starting conditions without any extraneous load applied to the belt. The transient period is about 85 milliseconds under the same conditions.

PART D

CONCLUSIONS

9. On basis of the results it is concluded that:

a. The Harvey Assist Feeder did not perform the task that it is designed to do, at least, not in conjunction with the 20mm aircraft gun Mk 16. Insufficient tests were conducted to definitely establish its performance in conjunction with the 20mm aircraft gun AN-M3.

b. No definite conclusions can be drawn concerning the location of defects in the design of booster since completely satisfactory operation was never obtained. The tests were terminated after the anti-roll back ratchet wheel had failed.

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20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Twelfth Partial Report

on

20mm Aircraft Guns, AN-M3 and AN-M24
Experimental and Developmental Tests

Final Report

on

20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

Classification control in accordance with
Executive Order 10850, dated January 10, 1953

J. Buel
8/4/54

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Naval Ordnance Test Station
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TAMMERS PRACTICE TEST (Continued)

Date Allocated Date, 28-10 Serial Number 22040

Date	Round* In Belt Pistol	Total Bullets	Bullets On Belt Pistol	Total Bullets On Belt Pistol	Pistol Type	Pistol Type (P.T.)	Milling Time Total Foliation Foliation Foliation P.D.C.	Milling Time Current Foliation P.D.C.									
2-25-52	65	3	64	64	TC	TC	600	1110	-	-	-	-	-	-	-	-	-
2-25-52	62	72	644	644	TC	TC	600	6224	-	-	-	-	-	-	-	-	-
2-25-52	100	33	937	937	TC	TC	600	2119	-	-	-	-	-	-	-	-	-
2-26-52	600	711	(MATERIAL) APPLIED TO PISTOL.	(MATERIAL) APPLIED TO PISTOL	(MATERIAL) APPLIED TO PISTOL	(MATERIAL) APPLIED TO PISTOL	-	-	-	-	-	-	-	-	-	-	-
2-26-52	100	16	840	829	SC	SC	600	2139	2	2	2	2	2	2	2	2	2
2-26-52	175	162	957	949	SC	SC	600	2439	-	-	-	-	-	-	-	-	-
2-27-52	228	5	233	-	TC	TC	600	2624	-	-	-	-	-	-	-	-	-
2-27-52	225	3	223	213	TC	TC	600	2404	-	-	-	-	-	-	-	-	-
2-27-52	62	3	616	616	TC	TC	600	1606	-	-	-	-	-	-	-	-	-
ROUTINE CLUTCH ADJUSTMENT REQUIRED ON 1000-SERIES TESTS TO 7000-SERIES OPERATOR TESTS BUT NOT CLUTCH IS ADJUSTED.																	
2-27-52	212	54	8910	8909	TC*	TC*	600	1662	-	-	-	-	-	-	-	-	-
2-27-52	188	60	9010	9011	SC	SC	600	1682	-	-	-	-	-	-	-	-	-
2-27-52	149	31	9141	9140	SC	SC	600	1615	-	-	-	-	-	-	-	-	-
ROUNDS REQUIRED TO RESET CLUTCH ACTUATOR.																	
2-27-52	117	6	8940	-	SC	SC	600	1619	-	-	-	-	-	-	-	-	-
2-27-52	113	27	1074	1076	SC	SC	600	1665	-	-	-	-	-	-	-	-	-

2-27-52 600 P.M. APPLIED TO THE PISTOL AND 7000 P.D.C. APPLIED TO SCREW. THE CLUTCH WAS TURNED BACK AND FORWARDS 1000-SERIES TESTS TO 7000-SERIES TESTS AS TESTED. ELEMENTS WERE REMOVED AND TESTS TO RESTORE OPERATION OF SCREW. PISTOL TESTS WILL NOT TAKE PISTOL APPLIED TO SCREW. SCREW TO PISTOL ADJUSTED VERY CAREFULLY.

ROUTINE CLUTCH ADJUSTMENT REQUIRED ON 1000-SERIES TESTS TO 7000-SERIES OPERATOR TESTS BUT NOT CLUTCH IS ADJUSTED.

2-27-52 1000 P.M. APPLIED TO SCREW. SCREW TO PISTOL ADJUSTED VERY CAREFULLY.

2-27-52 1000 P.M. APPLIED TO SCREW. SCREW TO PISTOL ADJUSTED VERY CAREFULLY.

2-27-52 1000 P.M. APPLIED TO SCREW. SCREW TO PISTOL ADJUSTED VERY CAREFULLY.

2-27-52 1000 P.M. APPLIED TO SCREW. SCREW TO PISTOL ADJUSTED VERY CAREFULLY.

2-27-52 1000 P.M. APPLIED TO SCREW. SCREW TO PISTOL ADJUSTED VERY CAREFULLY.

2-27-52 1000 P.M. APPLIED TO SCREW. SCREW TO PISTOL ADJUSTED VERY CAREFULLY.

2-27-52 1000 P.M. APPLIED TO SCREW. SCREW TO PISTOL ADJUSTED VERY CAREFULLY.

1000 P.M. ADJUSTED ON BUMPER SIDE OF PISTOL.
THIS TEST WAS TURNED BACK AND FORWARDS 1000-SERIES TESTS TO 7000-SERIES TESTS AS TESTED.

1000 P.M. ADJUSTED ON BUMPER SIDE OF PISTOL.
THIS TEST WAS TURNED BACK AND FORWARDS 1000-SERIES TESTS TO 7000-SERIES TESTS AS TESTED.

1000 P.M. ADJUSTED ON BUMPER SIDE OF PISTOL.
THIS TEST WAS TURNED BACK AND FORWARDS 1000-SERIES TESTS TO 7000-SERIES TESTS AS TESTED.

1000 P.M. ADJUSTED ON BUMPER SIDE OF PISTOL.
THIS TEST WAS TURNED BACK AND FORWARDS 1000-SERIES TESTS TO 7000-SERIES TESTS AS TESTED.

ROUTINE CLUTCH

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COMMUNITY SERVICES

TAKING ON THE DIA

Date	Hours	Hours	Cycles	Total	Power	Battery	Towing	Towing	Operating	Operating	Average Time	
					hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	
3-9-32	193	193	15	2167	-	1563	-	1563	-	1563	-	1563
3-10-32	193	63	480	781	1575	600	1600	600	1600	600	1600	
3-9-32	64	50	480	787	1575	600	1600	600	1600	600	1600	
3-10-32	64	7	480	787	1572	600	2020	600	2020	600	2020	
3-10-32	64	4	480	781	1570	600	2020	600	2020	600	2020	
3-11-32	64	25	4800	781	1571	600	2020	600	2020	600	2020	
3-10-32	64	4	4800	780	1573	600	2020	600	2020	600	2020	
3-11-32	64	4	4800	784	1579	600	2020	600	2020	600	2020	
3-11-32	64	8	4800	782	1577	600	2020	600	2020	600	2020	
3-11-32	64	3	4800	783	1570	600	2020	600	2020	600	2020	
3-11-32	64	4	4800	785	1574	600	2020	600	2020	600	2020	
3-11-32	60	11	4800	784	1573	600	2020	600	2020	600	2020	

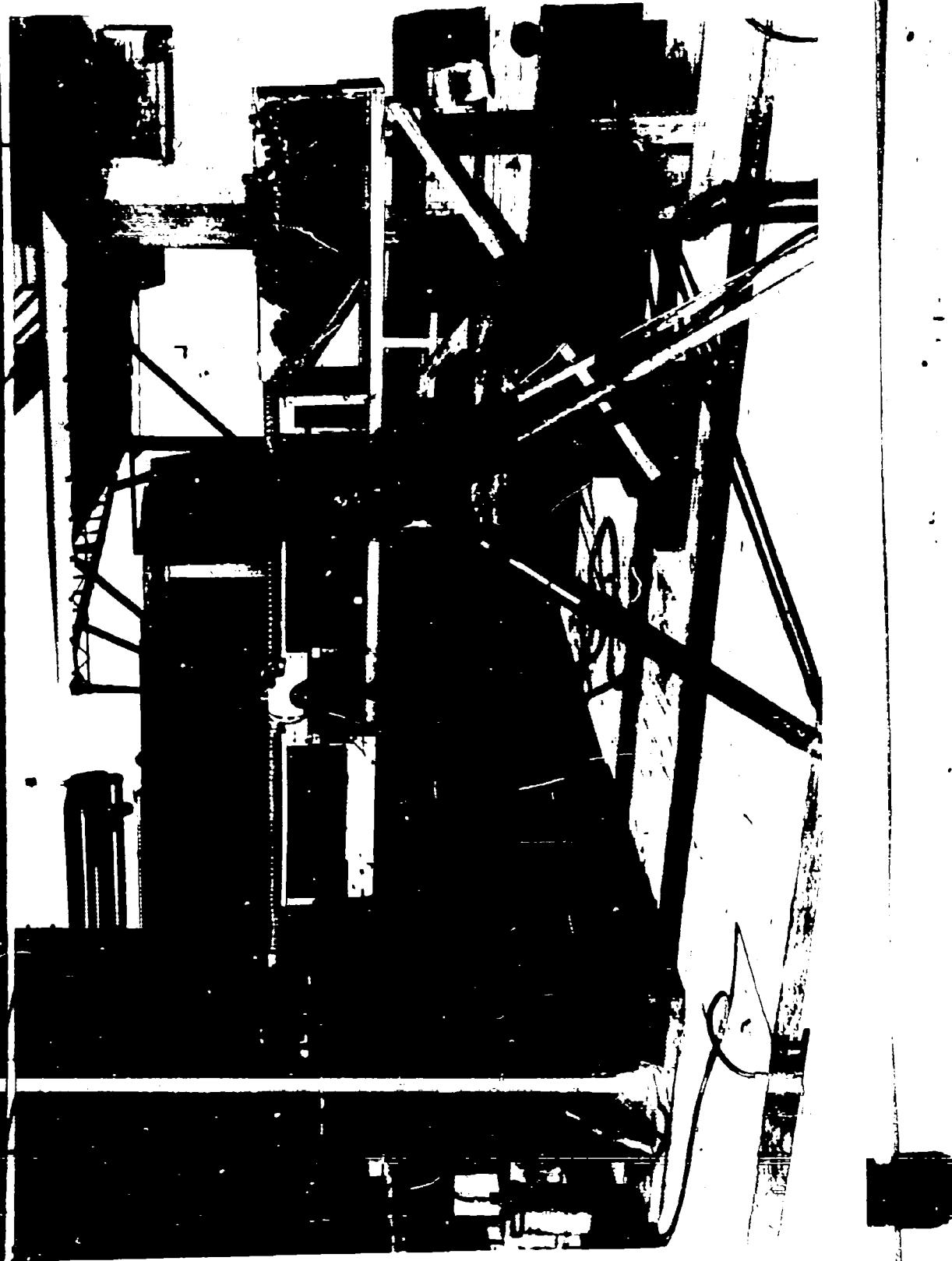
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Mc 16 20mm Gun - ~~Mc~~ 8/Vod O Gun - Peed Mechanism, Harvey Assisted Feeder, Ammunition
Box and Mitchell Movie Camera.

Figure 1

APPENDIX 3



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DIRECTION OF FEED

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20MM AMMO FEEDER

TOP VIEW

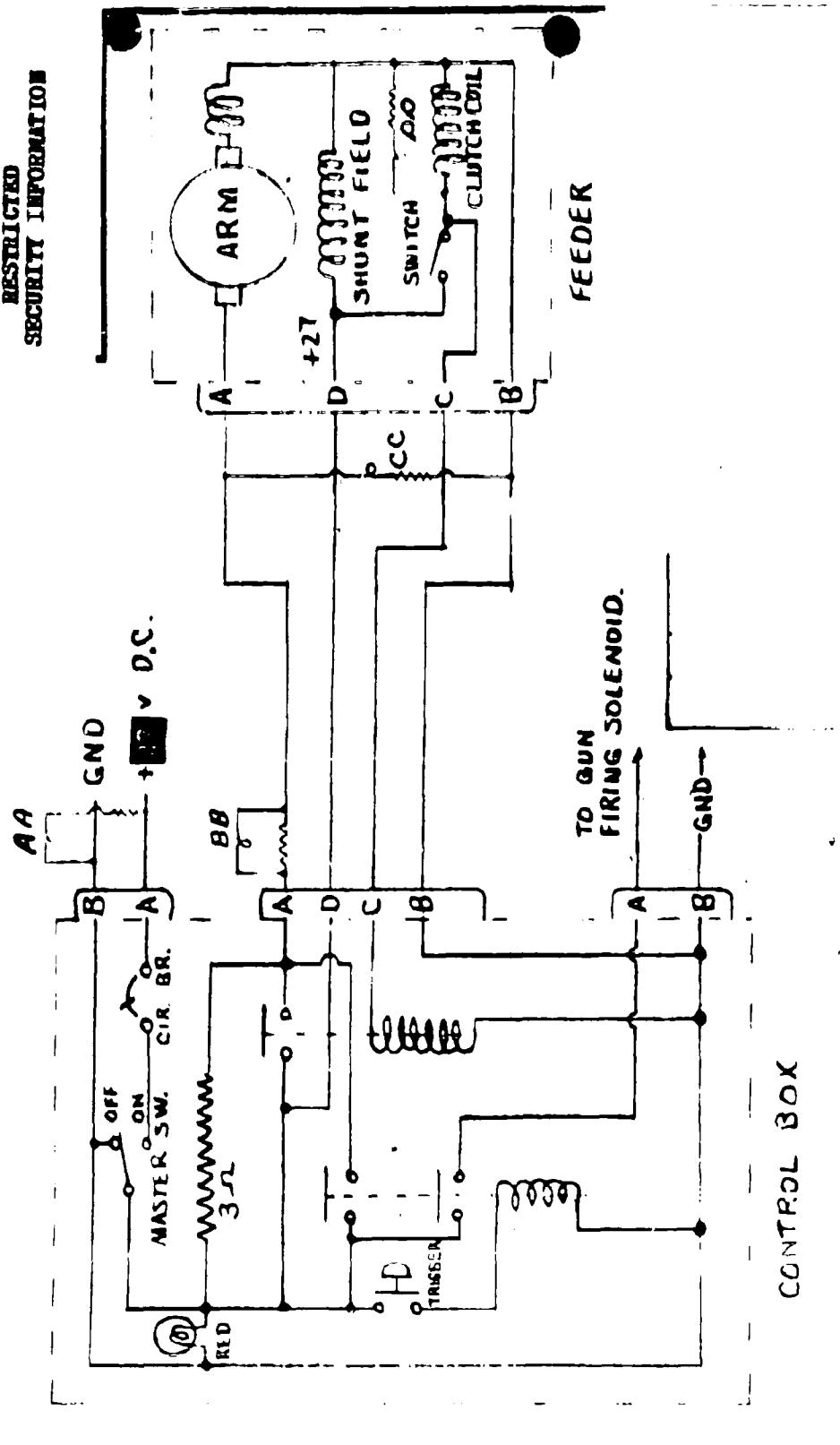
FIRST LOOP

CLUTCH SWITCH
BOOSTER MOTOR

20 MM AMMO FEEDER
BOTTOM VIEW

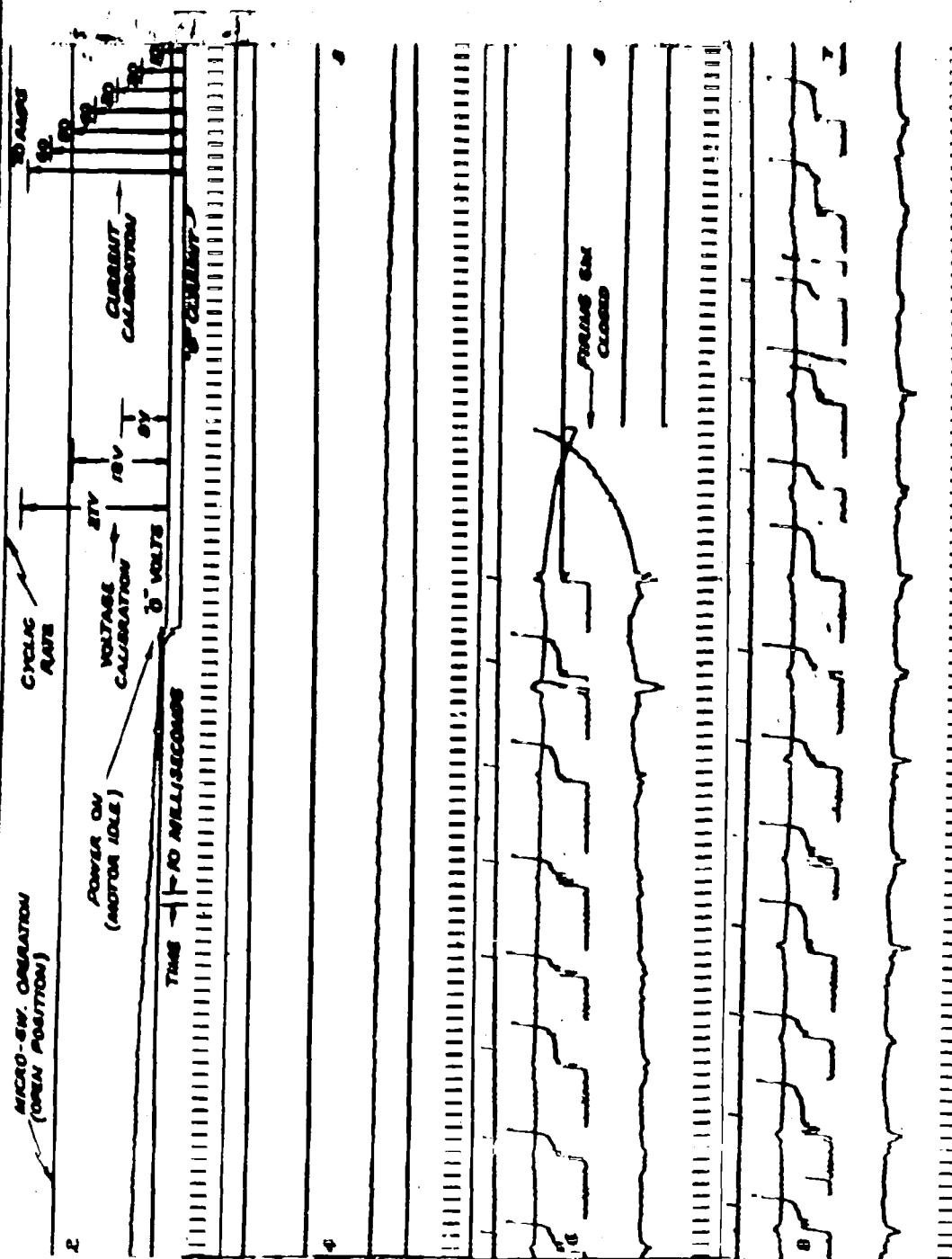
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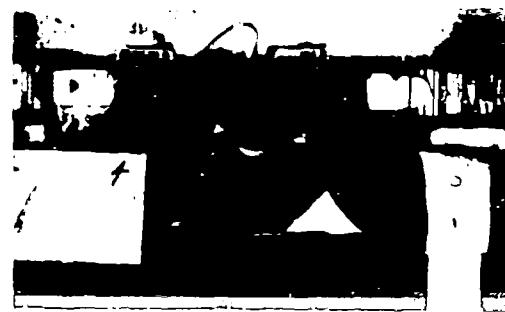
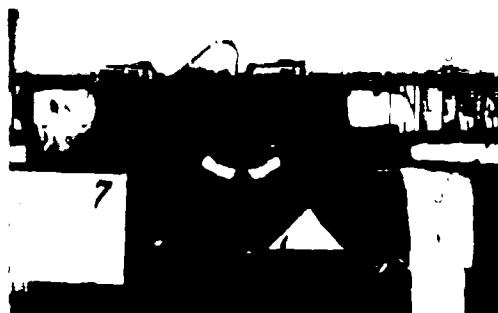
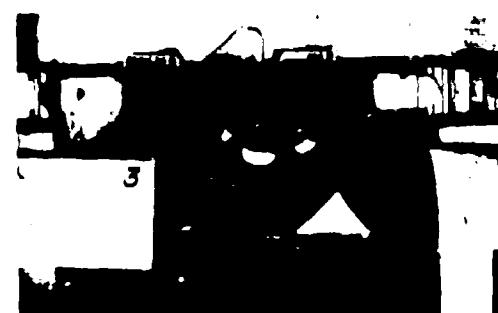
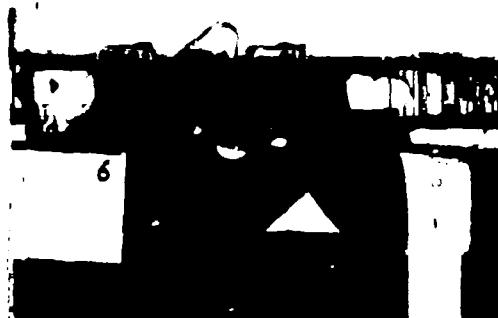
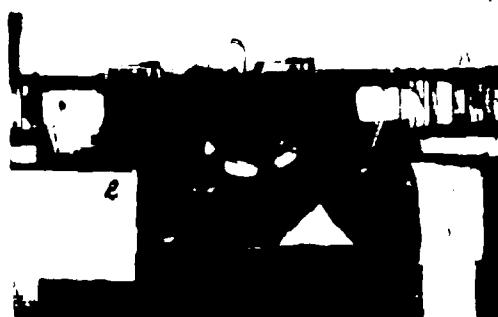
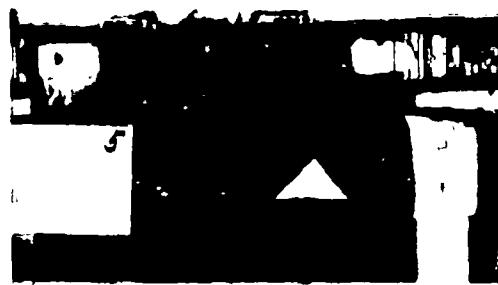
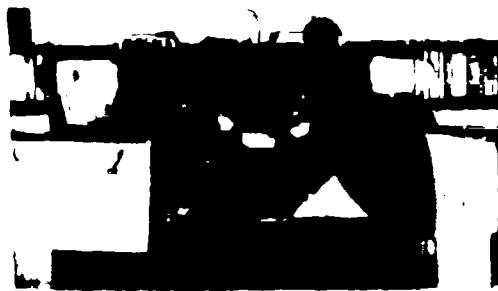


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HPD 42-164
Harvey Assistant Professor
Feed Mechanism 1/2 a
Dolby 500 (Unknown)



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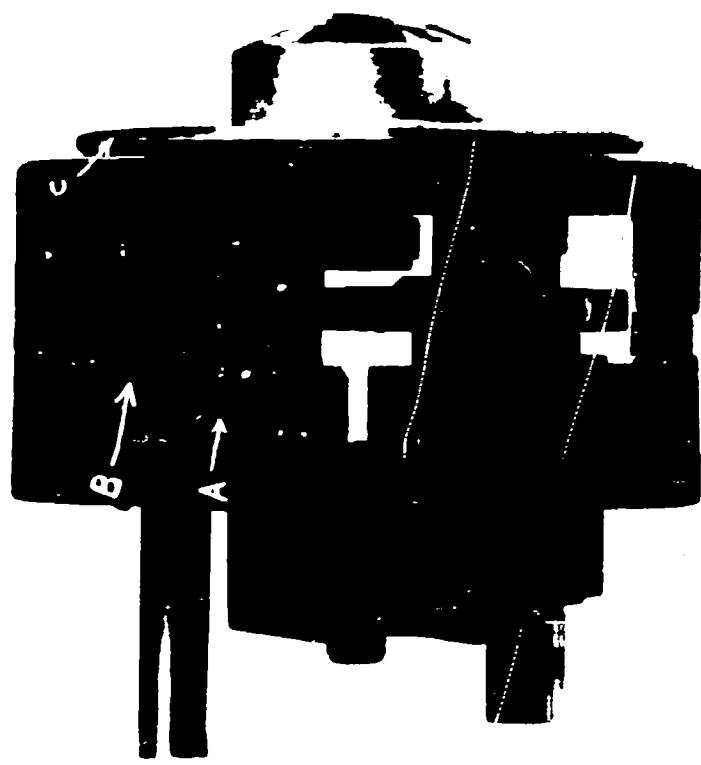
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TRANSMISSION BY TELETYPE. FILED AND INDEXED. PULLED THROUGH KEYER. ASSIST
FINGER 1: Shows Ammunition box with 1000 rounds of 105mm High Explosive
disassembled. Box is open and the lid is propped up. Lid is held by a
hand. Lid is held by a hand. Lid is held by a hand. Lid is held by a hand.
Finger 2: Shows Ammunition box with 1000 rounds of 105mm High Explosive
disassembled. Box is open and the lid is propped up. Lid is held by a
hand. Lid is held by a hand. Lid is held by a hand. Lid is held by a hand.
Finger 3: Shows Ammunition box with 1000 rounds of 105mm High Explosive
disassembled. Box is open and the lid is propped up. Lid is held by a
hand. Lid is held by a hand. Lid is held by a hand. Lid is held by a hand.
Finger 4: Shows Ammunition box with 1000 rounds of 105mm High Explosive
disassembled. Box is open and the lid is propped up. Lid is held by a
hand. Lid is held by a hand. Lid is held by a hand. Lid is held by a hand.

APPENDIX B

NP 9 46720

Gear reduction shaft clutch assembly
end block - back clutch plates, front
clutch plates.

FIGURE 7



U.S.N.P.G. DAHLGREN, VIRGINIA
3 INCHES

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20mm Ammunition Assist Feeder
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